

Terrible triad of the elbow: treatment protocol and outcome in a series of eighteen cases

Jérôme Pierrart^a, Thierry Bégué^{b,*}, Pierre Mansat^c, GEEC^d

^a Department of Orthopaedics and Trauma Surgery, Hôpital Avicenne, AP-HP, Univ Paris XIII, 125 rue de Stalingrad, 93909 Bobigny, France

^b Department of Orthopaedics and Trauma Surgery, Antoine Béchère Hospital, AP-HP, Univ Paris-Sud, 157 rue de la Porte de Trivaux, 92140 Clamart, France

^c Department of Orthopaedics and Trauma Surgery, C.H.U. Toulouse/Purpan – Place du Dr Baylac, 31059 Toulouse, France

^d GEEC: Groupe d'Etude de l'Epaule et du Coude (French Society of Shoulder and Elbow Surgery), France

KEYWORDS

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ABSTRACT

The terrible triad is an uncommon injury, which includes an elbow posterior dislocation with fractures of the radial head and coronoid process of the ulna. In addition there is rupture of the lateral and medial collateral ligaments. The short-term and long term results are historically poor, with a high rate of complications. The main objective of this study is to report the results of a multicentre study of patients who sustained the terrible triad injury focusing on surgical treatment in order to offer a standardized surgical protocol.

We retrospectively review the results of surgical treatment of eighteen terrible triads from a multicentre study of 226 elbow dislocations. At an average follow up of 31.5 months postoperatively, all eighteen patients returned for clinical examination, functional evaluation, and radiographs. The mean MEPS score value was 78 (25–100), which correspond to three excellent results, ten good results, three fair results, and two poor results. Five early and three late complications were reported.

This particular case of elbow dislocation is very unstable and leads to many complications. The surgeon should attempt to restore stability by preserving the radial head whenever possible or replacing it with prosthesis otherwise, by repairing the lateral collateral ligament and performing fixation of the coronoid fracture. If after anatomical restoration of stability elements, the elbow remains unstable, options include repair of the medial collateral ligament or stabilization assumed by hinged external fixator.

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Introduction

Among elbow dislocations, the terrible triad is a specific injury described by Hotchkiss [1] with concomitant fractures of radial head and coronoid process of the ulna, ligamentous disruptions and posterior dislocation of the elbow. This injury is complex with rupture of elements of the different components of the elbow's stability: the anterior column by fracture of the coronoid process of the ulna and the medial and lateral columns by disruption of ligaments. In addition the presence of radial head fracture affects the lateral column. As a consequence, the terrible triad is an injury which damages the primary and secondary stabilizers of the elbow [2]. This injury generates a severe acute instability at the time of injury, and far away from the initial trauma, may induce chronic elbow instability, ectopic bone formation, chronic pain, stiffness and arthritis. Few clinical series have been published [3–5], and due to the difficulty of

positive diagnosis and treatment protocol, there is a lack of information available regarding ideal techniques for treatment.

The purpose of this study is to report the results of a retrospective multicentre study of 18 patients with terrible triad injuries to evaluate surgical treatment modalities in order to offer a standardized surgical protocol.

Materials and methods

Between 2000 and 2008, screening a multicentre national database driven by the authors, 226 elbow dislocations were identified. The inclusion criteria were defined as follows: an elbow dislocation with at least a fracture of the coronoid and radial head, and a minimal follow-up of 6 months for evaluation. Exclusion criteria were: 1) others associated injuries such as olecranon fractures, 2) Monteggia fracture, 3) concomitant ipsilateral wrist, hand or shoulder injuries, or 4) an isolated closed treatment for the injured elbow. From the initial 226 cases, 18 elbow dislocations with inclusion criteria parameters were identified and were selected for evaluation. As the study didn't modify any treatment protocol, according to our National Law, Ethics committee approval was not needed.

* Corresponding author at: Department of Orthopaedics and Trauma Surgery, Antoine Béchère Hospital, AP-HP, Univ Paris-Sud, 157 rue de la Porte de Trivaux, 92140 Clamart, France. Tel.: +33 145 374 734.

E-mail address: thierry.begue@abc.aphp.fr (T. Bégué).

Table 1
Type of injuries for each component and treatment

Case	RH	Treatment	CP	Treatment	Surgical approach	LCL	MCL
1	3	ORIF	1	Suture	L	TO	-
2	3	Prosthesis	1	-	L	TO	TO
3	3	ORIF	1	-	L	TO	-
4	3	ORIF	1	-	L	S	-
5	3	ORIF	2	-	L	-	-
6	3	Prosthesis	1	-	L	TO	-
7	3	Prosthesis	1	-	L	-	-
8	3	Prosthesis	1	-	L	TO	-
9	3	Prosthesis	1	-	L	TO	-
10	2	ORIF	1	-	L	TO	-
11	3	Prosthesis	1	-	L	S	-
12	2	ORIF	2	-	L	S	-
13	2	ORIF	1	-	L	-	-
14	3	Prosthesis	3	Screw	L & M	-	-
15	3	ORIF	1	-	L & M	S	S
16	2	Resection	1	-	L	-	-
17	2	ORIF	2	Screw	L & M	S	TO
18	3	ORIF	1	-	L	TO	-

ORIF: open reduction and internal fixation; TO: trans-osseous fixation; S: direct suture; RH: radial head fracture; CP: coronoid process fracture; LCL: lateral collateral ligament; MCL: medial collateral ligament; L: lateral approach; M: medial approach and “-”: not repaired.

The fractures of the radial head were classified according to the Mason's classification [1,5]. The fractures of the coronoid process of the ulna were classified according to Morrey-Regan based on the percentage of the process fragment separated from the ulna [1,4,5].

All eighteen patients were reviewed for clinical examination, functional evaluation, and radiographs of the injured elbow. Outcome was evaluated using Mayo Elbow Performance Score (MEPS) [6] and classified as follows: excellent when over 90 points; good, from 75 to 89 points; fair, from 60 to 74 points; and poor, inferior to 60. Other criteria were the flexion-extension arc of motion, the amplitude of flexion, the level of flexion contracture, and degree of extension gap. Radiographic signs of degenerative arthritis were also rated according to Broberg and Morrey [7]. Different other criteria were included for evaluation on plain radiographs, i.e. heterotopic bone formation, radial head restoration and coronoid process union. Average follow-up of this study was 31.5 months and ranged from 7 to 97 months.

Results

In the eighteen patients included, the mean age of the 6 females and 12 male patients was 43.8 years (range, 19–56). None terrible triad had an associated ulnar nerve damage, open wound trauma or vascular compromise. The fractures of the radial head were type II in five cases and thirteen were type III. The fractures of the coronoid process were fourteen types I, three types II, and one type III.

All patients of this study were treated surgically (Table 1). Treatment was done as follows: manual external manoeuvres for reduction of the dislocation under anaesthesia; joint stability testing after reduction; coronoid process repair (1 lasso-type suture, 2 ORIF by medial approach, 15 not repaired); radial head fractures surgery (10 ORIF, 7 radial head prosthesis, 1 radial head resection). For ligaments repair, 13 lateral collateral ligaments were fixed either by direct suture (5), or trans-osseous fixation (8). Medial collateral ligaments were repaired in only 3 cases, by direct suture (1) or trans-osseous fixation (2). In a specific case of a woman 43-years old who sustained a terrible triad treated only from the lateral side, we have added a hinged external fixator because of persistent instability of the injured elbow (Figure 1). Initial trauma was a posterior dislocation of the right elbow

(dominant) with a Mason III radial head and Morrey I coronoid fractures. Acute instability of the elbow was still present after replacement of the radial head by a prosthesis and suture of the lateral collateral ligament complex. To get stabilisation of the joint, protect sutures and allow early motion, additional lateral insertion of this hinged fixator was carried out.

Five postoperative complications were seen with two cases of wound dehiscence, one dislocation of the humeroulnar joint and two radial heads prosthesis dislocations. Late complications were limited to one radioulnar cross-union, one ulnar nerve neurapraxia with pain and one atypical cutaneous pain of the forearm.

Global functional result, according to MEPS, was of 78, representing three excellent, ten good, three fair and two poor results. An objective positive outcome was seen in 13 of the 18 patients (72%). The mean flexion was 135° and the mean extension deficit was 21°. Sixteen patients had a normal pronation (89%) and fourteen (78%) a normal supination (Table 2). As a global result, twelve of the eighteen patients had a functional arc of motion, according to the criteria of Morrey [8].

Radiographic evaluation (Table 3) was available for seventeen of the patients. We found one persistent dislocation of the elbow, one non-union of the radial head and six non-unions of the coronoid process. Elbow post-traumatic arthritis was seen as moderate in four patients, little in five and none in eight. Heterotopic bone formation around the elbow joint was present in 11 of the 17 patients.

Discussion

The terrible triad of the elbow causes extensive damage to the ligaments and osseous structures, which provides acute elbow stability. For adequate evaluation of all injured items, complete radiographic evaluation must be done after reduction, and the best treatment protocol must be based on its results. Positive diagnosis may be difficult, as disruption of the ligaments is not seen on x-rays. Majority of terrible triads will require open repair and isolated closed management is not an adequate treatment [5,9] as re-dislocation can occur even with application of a posterior splint.

Surgical treatment of terrible triads of the elbow needs a complete repair of osseous and ligamentous lesions to get a

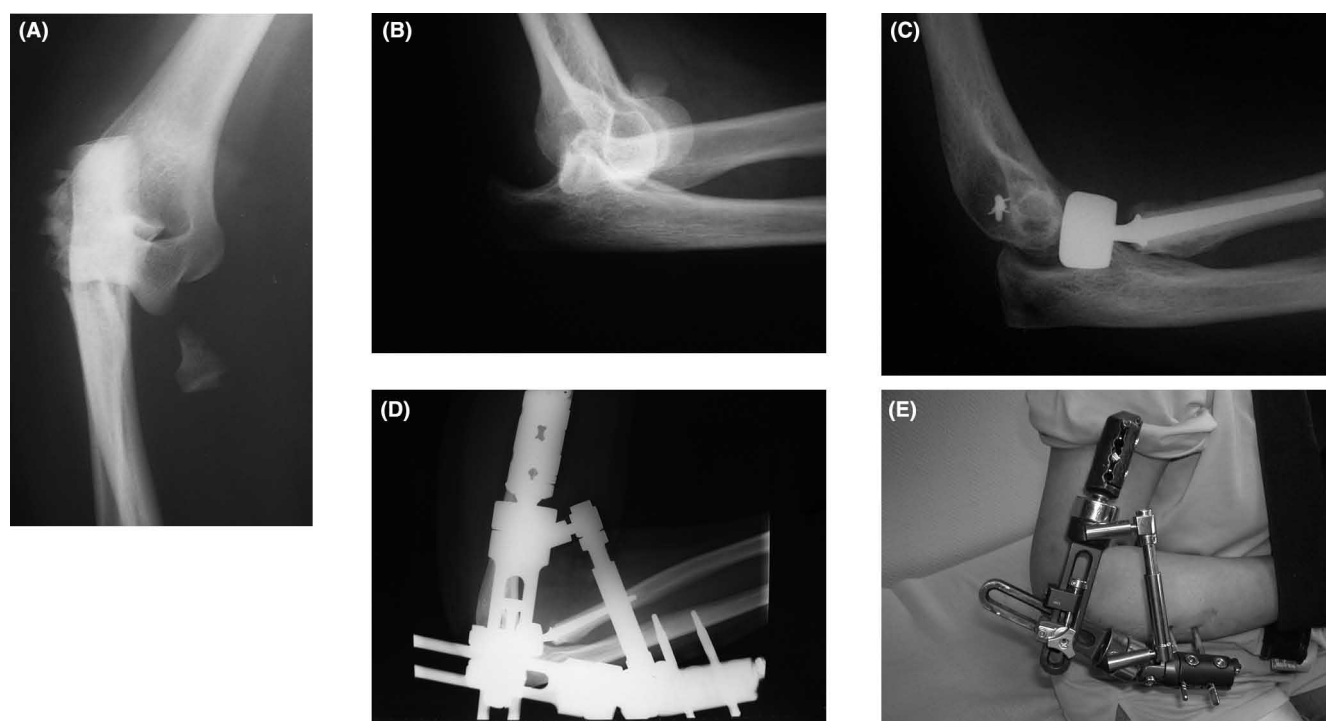


Fig. 1. Terrible triad in a 43-year-old woman. (A and B) Lateral and AP views of a posterolateral dislocation of the elbow joint with associated radial head and coronoid process fractures. (C and D) Post operative radiographs before (C) and after (D) the application of an hinged external fixator. (E) Clinical aspect with the Exfix.

Table 2
Clinical results at follow-up

CASE	Flexion	Extension	Pronation	Supination	MEPS
1	140	0	N	N	100
2	140	30	N	N	85
3	150	10	N	N	80
4	140	0	N	N	100
5	130	10	N	N	85
6	150	30	N	N	100
7	140	5	N	N	85
8	140	15	N	N	85
9	130	15	N	N	85
10	140	5	N	N	85
11	130	60	<45°	<45°	25
12	140	25	N	<45°	65
13	130	50	N	0	55
14	140	30	N	N	75
15	130	50	<45°	<45°	75
16	120	0	N	N	70
17	120	30	N	N	75
18	120	10	N	N	70

N: normal motion with no restriction; MEPS: Mayo Elbow Performance Score.

stable joint, allowing immediate post-surgical motion. To do so, protection of restored anatomical structures, as well as recurrence of elbow instability, may lead the surgeon to use a hinged external fixator to get stability and allow motion. Treatment goals are 1) restoration of integrity and stability of the ulnohumeral and radiohumeral joints, 2) reduction and stabilisation of fractured bony structures and 3) allowance of early active motion to limit flexion-extension contracture. Among our five patients with final bad result, one had a radial head resection, one didn't get repair of the lateral collateral ligament, and a Morrey type II coronoid fracture was not fixed.

Ring et al. have published a series of eleven terrible triads of the elbow [5]. Four radial heads had been resected, none

Table 3
Radiographic lesions at follow-up

Radial head nonunion	Coronoid nonunion	Persistent dislocation	Arthritis (Broberg & Morrey)			
			0	1	2	3
1	6	1	8	5	4	0

of the coronoid fractures had been repaired, and the lateral collateral ligament had been repaired in only three cases. As a consequence, their results are less satisfactory than others (Figure 2). Results of treatment are rated as unsatisfactory for seven of the eleven patients. Five, including all patients treated with resection of the radial head, have a re-dislocation after the operative treatment. This management, not linked to severity of anatomical lesions, may explain insufficient results reported. We recommend systematic reconstruction of the radial head, coronoid process and lateral ligament complex to reduce complications, as comparative results show better outcome with this type of management (Figure 2). Proposals of Pugh et al. [4] for treatment of terrible triads seems quite standardized. They get a MEPS's average result of 88 (45–100), close to our 78 average one. For this author, a standardized treatment protocol can be proposed. Lateral collateral ligament must be repaired in all cases, radial head fractures are fixed with ORIF as soon as possible, or if comminuted, replaced by an implant. Anterior column is repaired either by suture of anterior capsule or fixation of coronoid process. If the elbow is still unstable after adequate treatment such described, a hinged external fixator or repair of the medial collateral ligament must be done.

For coronoid process fracture and anterior rupture of the capsule, many authors recommend suturing the capsule, which is attached to the coronoid process for the Morrey I-type [4,9]. There is still controversy for fixation or not of small coronoid fragment (Type I). Terada [9] advocates a systematic fixation to get an anatomical reduction and restore stability. In a previous

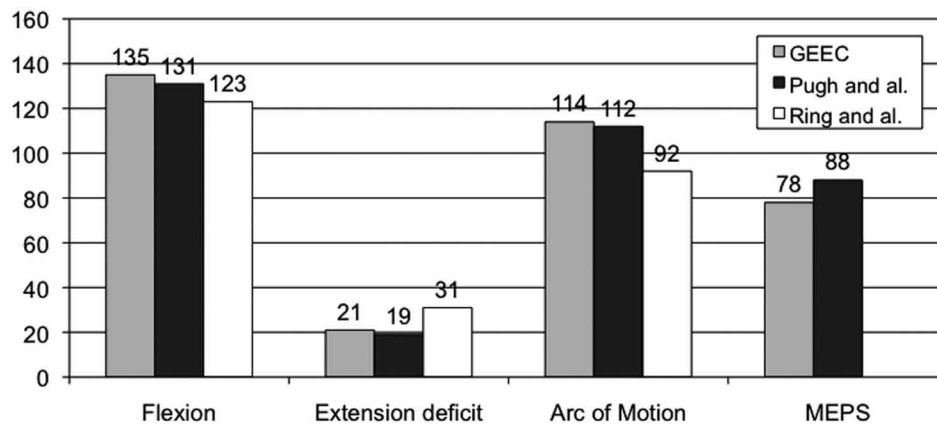


Fig. 2. Comparative results. GEEC: national multicenter study; Pugh et al. [4]; Ring et al. [5].

paper, Regan and Morrey [10] are not in favour of a surgical fixation on such lesions. New techniques for adequate fixation such as anchors may help fixation of very small fragments. We advise to fix it as often as possible, as the fixation of the coronoid process fracture allows restoration of the anterior column. According to Morrey and An [11], 50% of the height of the coronoid process is necessary to ensure humeroulnar sagittal stability. The coronoid has a role as a buttress to posterior ulnar displacement [12]. In case of instability, whatever the height of the fragment, reconstruction should be done as soon as possible. Based on above, Type II and III fractures management is stable surgical fixation, by screw whenever possible [4].

Minimally displaced radial head fractures are treated functionally. Displaced or comminuted radial head fractures (Mason II and III) are treated operatively. If the fixation of the radial head is not possible, restoration of the radiohumeral joint with use of a radial head implant must be considered [13]. Resection of radial head alone is contra-indicated in the setting of the terrible triad as it increases the instability of the elbow [2,14]. Medial collateral ligament disruption, common in elbow dislocation, gives the radial head to assume the role of an important stabilizer [13]. The implant replacement allows protection of the medial collateral ligament's healing and early motion.

For repair of the lateral collateral ligament, well accepted management of disruptions is systematic repair either by simple suture or transosseous fixation [4]. The lateral and medial collateral ligaments are considered to be important stabilizing structures [2]. However, medial collateral ligament repair doesn't seem to be necessary [15].

After complete open treatment of all bony and ligamentous injuries, elbow stability is evaluated. In case of a recurrent elbow acute instability, respective advantages of external fixation or medial ligamentous repair have not been well established. Some teams are in favour of complete ligamentous reconstruction [3], as others [15] prefer the external protection which allows quick articular mobilisation [16] with no strains on the repaired ligaments. In any type of surgical treatment, goal is to maintain congruent humero-ulnar, radio-ulnar and radio-capitellar joints and allow movement through the anatomical centre of rotation of the elbow. Hinged external fixator allows early motion all over different injuries healing and fusion time. This method restores a functional arc motion in difficult cases [16].

Conclusion

Management of terrible triad of the elbow remains a significant challenge for orthopaedic surgeons. They must

restore the integrity of the elbow repairing all structures, using a standardised surgical protocol, which gives the best results and prognosis by restoration of the elbow stability. If instability's persists after fixation or suture of the bony lesions and lateral collateral ligament, surgeon must consider an additional procedure repairing the medial collateral ligament or fixing the joint with a hinged external fixator. In such cases with a non-confident ligaments repair, protecting the elbow by hinged external fixator allows early motion during healing and union rates. Moreover, it limits flexion contractures at long-term follow-up to obtain a functional arc of motion.

Conflict of Interest Statement

The authors, immediate families, and any research foundation with which they are affiliated with did not receive any financial payments or other benefits from any commercial entity related to the subject of this article.

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